

EFFECT OF PROPRIOCEPTION ON RIDING COMFORT OF SELECT VEHICLE: AN EXPERIMENTAL STUDY

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Abstract

The handling comfort of four wheelers is highly important in these days of high competition for survival in the market. Travelling in a car also causes vibration and that results in physical strain. Physical condition permits and able to bear certain level of disturbances caused due to vibrations caused. This paper aims at understanding the point of discomfort due to vibration that is caused while riding at the point of steering-wheel and seat of the handler. Further, it is proposed to check for variation between professional handlers and common handlers and between male and female handlers. This study was conducted as an experimental study. The sample size was thirty.

Key Words: Proprioception, Vehicle dynamics, Point of discomfort and Handler

Introduction

Automobile industry in general is fast growing with much advanced technology, comfort, automation etc. Individuals also differ and hence various brands have emerged. Emerging increasing market gave lot of scope for many companies. Globalization also paved wave for having brands of individual choice in any part of globe. The designing of car specifically done based on technical advice of juries. Customers' evaluation is not a factor considered while designing a car. The comfort for a passenger is decided based on the drivability, body movement because of vehicle condition, road condition and vibration etc. Due to this, body position or part (s) of body movement takes place.

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This movement is known as proprioception. Proprioception is an individual's ability to integrate the sensory signals from mechanoreceptors to thereby determine the body segment positions and movements in space (Vimalathithan et al., 2020). In the case of proprioception, the sensor is the skin or the muscle part that is located all over the body of human beings. This is the response of the body to the requirement of the environmental system. Deane (2017) stated one's movement depends on understanding of oneself and the surrounding. Motion bases are friction, stretches and impact. Alpha-motor neurons stimulate skeletal muscles and gamma-motor neurons stimulate intrafusal muscles and both are interlinked. Vibration stimulus will indicate the level of frequency and then the vibration perceived is measured based on the response to the vibration. Vibration at the place of seat can be measured and the response to body to various levels of vibration was observed and the exact point of discomfort of a handler can be studied.

Literature Review

A study using cats found that nerves could be included in studying the locomotion. Proprioception is influenced by the muscle size, length, velocity and its force (Arthur and Monica, 1998). Godai and Jiro (2016) found that the perception on bouncing is based on the hand position and when it was close to point of coincidence. Also, the proprioception was the highest when both palm were together. Kenri and Ayaka (2017) wanted to identify drift in proprioception using shadow of human body and they found that there was no significance difference in drift between active and static positions irrespective of type of shadow. Antonio et al., (2000) found that reflex was high for small afferent fiber and vibration was higher for patients than the normal group. Flanagan et al., (2017) pointed realistic off-road conditions to test drivers in complex situations.. Parking, speed breakers near signals, parking by blocking

halfway etc., are the intervention. There was difference in these aspects between the handlers of manual and automatic vehicles.

Need for the Study

Jones et al., (1992) pointed that study is needed to check whether threshold will change the displacement of the subjects. Jia et al., (2016) pointed that brain has to mediate and interpret proprioception information from various receptors. Proprioception concept is used in medicine, sports etc. But, involving human studies are still needed. Marketing starts with customers and ends with customers for every product. This expensive product also mainly designed by engineers and if it based on the customers as well; it would have been leading to higher level of satisfaction among handlers.

Research Gap

The reviews were mainly indicated that Psychophysics subject application was widely used in the field of medical science and mainly to treat the patients and in sports science to rescue the players. Perception of handlers of car to know the comfort level and their proprioception that leads to discomfort will help to modify the car to satisfy the customers. Few studies were performed relating to automobile industry as well. But, there was not much observed relating to comparison between different categories of respondents to make product differentiation. This study focuses on identifying the point of discomfort of passenger car handlers and comparing this with male and female categories and also between professional and non-professional handlers.

Scope of the Study

The present study scope is to check the point of discomfort among handlers of four-wheeler and that too Mahendra and Mahendra company's SUV 300 model. This studied the point where the handlers find the body movement (Proprioception) of handlers. Also, comparison between the threshold levels was made between professional and non-professional handlers. Similar to that a comparison between male and female handlers was also the scope of this study to check the variation of threshold levels of these categories.

Objectives

The present study has the following objectives:

- To identify the threshold point or point of discomfort of handlers vary for factors such as riding, handling, brake, performance and drivability;
- To verify the point of threshold varies between professional and nonprofessional handlers for the selected variables of driving comfort; and
- To check the variation if any between male and female and age groups of handlers in their threshold levels of selected variables.

Research Methodology

The study design is experimental one. The respondents were asked to have a test drive of SUV300 model of Mahindra and Mahindra. The time taken for each sample was approximately 40 minutes in an average. After their handling of the vehicle they were asked to fill the questionnaire which was developed by considering the statements of ten riders and pre-test was conducted. These statements were measured in ten point scale about the level of comfort and convenience of the aspects. The statements that were mentioned by at least six handlers relating to study variables such as riding,

handling, steering, performance and drivability were finalized. The researcher was next to them while collecting data during pilot study as well final data collection clarifying all the doubts. The reliability was tested using Cronbach alpha value and the values of these six variables ranged between 0.87 and 0.93 and so reliability was ensured. CFA was performed to ensure validity of the components of all the six variables mentioned above and the standard conditions of parameters such as GFI, CFI, NFI, AGF and RMSEA were met. This ensured the validity of the tool. The statistical tools used were t-test and ANOVA.

Findings

To study the objective about the comfort level of variables considered for the study, first the comfort level of riding, steering, handling, brake, performance and drivability of the vehicle was computed. The average and standard deviation of these variables were computed.

Table 1 Descriptive Statistics of Variables

Variables	N	Mean	Std. Deviation
Ride	90	6.4630	.63932
Steering	90	6.0921	.77401
Handling	90	6.4528	.79843
Brake	90	6.4852	.70074
Performance	90	6.8583	.65563
Drivability	90	6.7333	.62012

Primary data computed

The variables are measured in the ten point scale. The average of these six variables was above six and this indicated the comfort level was only to the acceptable level only. It was found that that the maximum comfort was found was the highest relating to performance of the vehicle SUV300. The comfort of the variable steering comfort was the least with the average of 6.09. The comfort level of various aspects such as ride, handling and brake system was almost the

same and it was around 6.45. The second comfortable aspect was 6.73. This being the basic SUV model and because of that the variables may be at acceptable level.

Variation of the variables based on age categories was analyzed by using ANOVA test.

Table 2 Comfort Level of Variables based on Age

Age		N	Mean	Std. Deviation	F	d.f.	Post-hoc
Ride	Up to 30	35	40.4286	3.01258	17.236**	(2,87)	3 Vs. 1&2
	31-45	37	39.1081	3.53383			
	Above 45	18	34.8889	3.25195			
	Total	90	38.7778	3.83590			
Steering	Up to 30	35	43.6000	4.96577	14.649**		3 Vs.1&2
	31-45	37	44.3514	5.41713			
	Above 45	18	37.2778	1.87257			
	Total	90	42.6444	5.41805			
Handling	Up to 30	35	26.5429	1.97548	17.071**		3 Vs.1&2
	31-45	37	26.7568	3.16584			
	Above 45	18	22.4444	3.05291			
	Total	90	25.8111	3.19372			
Drivability	Up to 30	35	27.7714	1.88001	21.372**		3 Vs.1&2
	31-45	37	27.5135	2.04968			
	Above 45	18	24.1111	2.37360			
	Total	90	26.9333	2.48049			
Brake	Up to 30	35	40.0571	3.23531	19.273**		3 Vs.1&2
	31-45	37	40.0811	3.59304			
	Above 45	18	34.2778	3.98240			
	Total	90	38.9111	4.20445			
Performance	Up to 30	35	28.2571	2.22741	10.064**		3 Vs.1&2
	31-45	37	27.7297	2.55657			
	Above 45	18	25.2222	2.34033			
	Total	90	27.4333	2.62250			

Primary data computed: ** one per cent level of significance

The test result indicated that all the variables differ based on age at one per cent level. Further, the mean value was the least among the age group of above 45 years respondents. The other two groups did not vary between them. The average level of these six variables was almost

the same for the age groups up to 30 years of age and 31 to 45 years of age. The above 45 years respondents along perceived the comfort level much lower than the two groups.

Gender based the difference was checked using Z-test and it was found as below:

Table 3 Gender and Difference in Comfort Perception

Variable	Gender	N	Mean	Z	p
Ride	Male	60	6.1972		
	Gender	30	6.9944	-6.875	0.001
Steering	Male	60	5.6381		
	Gender	30	7.0000	-14.185	0.001
Handling	Male	60	6.0208		
	Gender	30	7.3167	-11.298	0.001
Brake	Male	60	6.1000		
	Gender	30	7.2556	-11.759	0.001
Performance	Male	60	6.5375		
	Gender	30	7.5000	-9.091	0.001
Drivability	Male	60	6.4750		
	Gender	30	7.2500	-6.899	0.001

Primary data computed

In all the variables, there is difference in the comfort level based on the gender and it was found that the comfort level was perceived higher level by female respondents. The difference was at one per cent level. Female respondents perceived higher level of comfort because they might have basically higher level of tolerance limit.

The result of ANOVA for experience in driving and the study variables was similar as that of age of the respondents. In this test also, the study variables ride, steering, handling, brake, performance and drivability varied at one per cent. Also, respondents with more than 10 years of experience driving found to have the lowest level of perception of comfort levels and it differed with the two groups of driving experience up to 10 years of experience. This might be due to their experience they could find the differences sharply.

The difference based on professional handlers and others were tested using Z-test.

Table 4 Profession and Handling Comfort

Variables	Driving	N	Mean	Z	p
Ride	Driving	30	5.6778	-16.816	0.001
	Others	60	6.8556		
Steering	Driving	30	5.8524	-2.118	0.037
	Others	60	6.2119		
Handling	Driving	30	5.7417	-7.677	0.001
	Others	60	6.8083		
Brake	Driving	30	5.8000	-9.075	0.001
	Others	60	6.8278		
Performance	Driving	30	6.1583	-10.942	0.001
	Others	60	7.2083		
Drivability	Driving	30	6.1333	-8.893	0.001
	Others	60	7.0333		

Primary data computed

In the case of profession based variation also, it was observed that there was variation in all the six variables at one per cent level. Further, the result indicated that non-professional handlers' perception about the comfort level was higher than the professional handlers.

Professional handlers might be able to fix even the slight variations and that may not be the case of other handlers.

Suggestions

The comfort level of the vehicle by the handlers was only the acceptable level only. It was not fair or good or excellent. These aspects need to be improved and that will help to develop the comfort zone and leads to their satisfaction.

Older age group, men, experienced handlers and non-professional handlers have perceived the comfort level of handlers at low level compared to their counterparts. For this group, the product value is to be made known and the economic value of developing the comfort level product and guide them to decide to balance between cost and comfort.

Professional handlers are the ambassadors and manufacturers need to keep it mind to meet their level to increase the sale.

Manufacturer need to see that the comfort level should be above average otherwise this will be a failure model.

Future scope of study

The manufacturer needs to know various other factors that are important for handling such as gear, clutch etc. Further, there is need to periodically go for this experiment, say once in six years. More advanced experimental study can be used for more accurate result.

Conclusion

The study indicated that the handler found that the comfort level was acceptable level. Also, professional drivers, men handlers and aged group and men were with lower level of perception relating to riding, steering, handling, brake, performance and drivability.

References

Murukesan Vimalathithan, Venugopal Shankar and , C. Madhavi. Customer Perception-Based Approach to Improve Ride and Handling of Passenger Car. Shodh Sanchar Bulletin, Vol 10 (40), 2020. Pp.31-41.

Jones, Hunter and Irwin. Differential thresholds for limb movement measured using adaptive techniques. Perception and Psychophysics. 1992. Vol. 52(5). Pp. 529-535.

Godai and Jiro. Hand Positions Alter Bistable Visual Motion Perception. I-Perception. May-June 2016. Pp. 1-4.

. Kenri and Ayaka. Innocent Body-Shadow Mimics Physical Body. I-Perception. May-june 2017. Pp.1-8.

Jia, Gordon, Roger, Judith and Yu. Assessing proprioception: A critical review of methods. JI. of Sports and Health Science. 2016. Vol. 5. Pp.80-90.

. Antonio, Jessica, Giacinta, Fabricio, Angelo and Marco. Loss of Large-diameter Spindle Afferent Fibres is not Detrimental to the Control of Body Sway during Upright Stance: Evidence from Neuropathy. *Exp Brain Res*. 2000. Vol.135 Pp. 155-162.

Deane Juhan. *Jobs Body: A Handbook for Bodywork*. 2017. Pp. 186-197.

Flannagan, M., Bao, S., Pradhan, A., Sullivan, J. et al., "Varying Levels of Reality in Human Factors Testing: Parallel Experiments at Mcity and in a Driving Simulator," SAE Technical Paper 2017-01-1374, 2017.